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A METHODOLOGY FOR INTEGRATING ASSET VALUATION IN TRANSPORTATION ASSET MANAGEMENT

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ABSTRACT

Asset valuation is an essential component of effective asset management. It is an important method to demonstrate proper management of public assets and effective utilization of government's budgets. In addition, it allows agencies to demonstrate justifications of funds needed to preserve its assets. Asset valuation is used in standard reporting, depreciation schedules, auditor requirements and condition assessments. Several government regulatory bodies mandate agencies to report their Capital Tangible Assets' (CTA) values within their annual statement. For example, the Canadian Public Sector Accounting Board (PSAB), the Governmental Accounting Standard Board (GASB) and the New Zealand International Financial Reporting Standards (NZ IFRS) to name a few.

Integrating asset valuation in asset management is imperative to manage assets in the most optimized cost-effective ways while maintaining or enhancing the value of these assets. Furthermore, the increased movement towards Public Private Partnerships (PPP) raises the question of how to identify the optimum or practical asset value criteria in performance based specifications that provide the required Level of Service (LOS).

The objective of this paper is to present a research overview to develop an asset management methodology to integrate asset value and valuation concepts and techniques with performance measures, prediction models, life-cycle cost analysis, prioritization and optimization tools as well as decision-making tools of asset management state-of-the-practice.

Keywords: Asset Management, Asset Valuation, Maintenance, and Rehabilitation, Public Private Partnership

1. INTRODUCTION

The challenge of reduced budget, aging and deteriorating infrastructure, increasing traffic loading, increases the demand for implementing effective asset management to manage infrastructure assets cost effectively at acceptable LOS. In addition, the challenge of maintaining the road networks at the highest possible condition while investing the minimum amount of money will always keep transportation agencies searching for innovative approaches (Piñero 2003).

Several government regulatory bodies mandate agencies to report their Capital Tangible Assets' (CTA) values within their annual statement. For example, the Canadian Public Sector Accounting Board (PSAB), the Governmental Accounting Standard Board (GASB) and the New Zealand International Financial Reporting Standards (NZ IFRS) to name a few.

Furthermore, Asset value is used in performance based contracts, PPP, as shown in the example of the original New South Wales (NSW) of 2,115 lane-km network ten-year PPP contract (Yeaman 2007) which included specification of an annual increase of asset value up to 4% on the basis of written down replacement cost.

Asset valuation has gained movements in the literature; there is a focus to better understand the asset valuation methods and applicability to different civil infrastructures as well as development or improvement of new methods. In addition, several research activities have been undertaken in efforts to integrate asset valuation to the existing asset management state-of-the-practices (Amekudzi et al. 2002; Cowe Falls 2004; Cowe Falls et al. 2001; Cowe Falls et al. 2006; Herabat et al. 2002; Lemer A. C 1998; McNeil 2000; Tighe and Cowe Falls 2002; Dojutrek et al. 2012; Li et al. 2014).

2. PROBLEM STATEMENT

Although some research has been introduced, there is no comprehensive work done to incorporate asset valuation in asset management systems. An integration method is imperative to manage assets in the most optimized cost-effective ways while maintaining or enhancing the value of these assets.

Several government regulatory bodies mandate agencies to report their CTA values within their annual statement. As such, using financial/ accounting methods alone in reporting asset values may result in underestimating asset values. If the underestimated asset values are used as the basis of annual budget allocation, it may result in insufficient funding to preserve assets and therefore impact the overall network (Cowe Falls 2004).

Furthermore, the increased involvement towards PPP or performance based type of contracts to manage and maintain infrastructure assets raises the question of how to identify the optimum or practical asset value criteria in performance based specifications that provide the required level of service?

3. SCOPE AND OBJECTIVE

The objective of this paper is to present a research overview to develop an asset management methodology to integrate asset value and valuation concepts and techniques with performance measures, prediction models, life-cycle cost analysis, prioritization and optimization tools as well as decision-making tools of asset management state-of-the-practice. This is important to manage assets in the most optimized and cost-effective ways while maintaining or enhancing the value of these assets.

4. LITRETURE REVIEW

4.1 Asset Management

Transportation asset management has gained movement over the last two decades. Asset Management in basic terms is a systematic business process that employs strategic, engineering and economical means to provide holistic approach to managing infrastructure assets to meet specified performance measures' level of services. There are many definitions of Asset Management in the literature; however, a widely used definition is that of the Federal Highway Administration (FHWA) US department of Transportation (FHWA 1999) also adopted by Transportation Association Canada (TAC) (TAC 2013; FHWA 1999; TAC 1997)

“Asset management is a systematic process of maintaining, upgrading and operating physical assets cost-effectively. It combines sound business practices and economic theory, and it provides tools to facilitate a more organized logical approach to decision making. Thus, asset management provides a framework for handling both short- and long-range planning.”

A widely used Asset Management framework is illustrated in TAC pavement design and management guide shown in Figure 1 (TAC 2013; TAC 2001)

As shown in Figure 1, the framework is based on identifying the system's assets inventory, current status, and asset value and identifying the current underperformers. Furthermore, it shows that a comprehensive asset management system has the capability of looking at the future in terms of identifying future needs, alternative programs and costs, as well as calculating future asset values.

4.2 Asset Valuation Overview

Asset valuation is an essential component of effective asset management (TAC 2013). It is an important method to demonstrate proper management of public assets and effective utilization of tax payers' money. In addition, it allows agencies to demonstrate justifications of funds needed to preserve its assets (Lugg 2005). Asset valuation is used in standard reporting, depreciation schedules, auditor requirements and condition assessments (Byrne 1994).

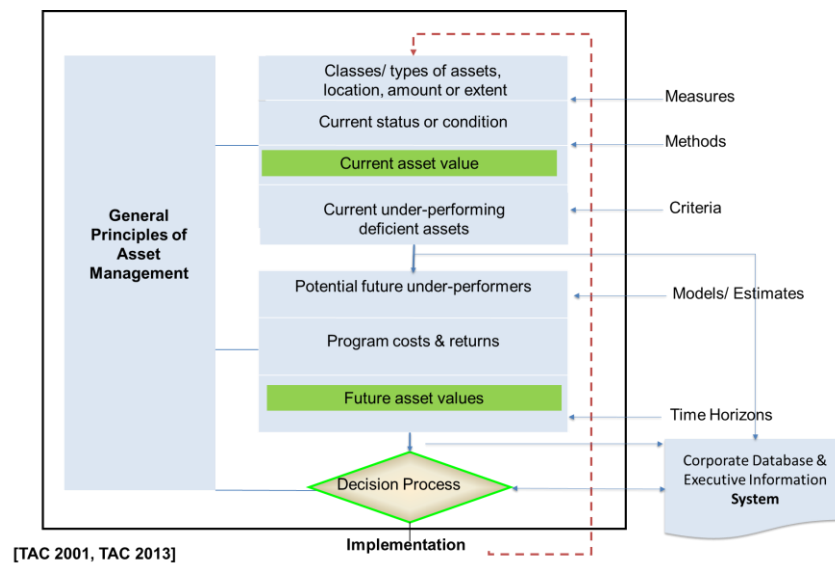


Figure 1: Overview Framework for Asset Management

The American Institute of Real Estate Appraisers (AIREA) defines asset valuation as the process of estimating the value of a specific asset at a given date; it measures the relative value or wealth of asset over time (AIREA 1987). Marston et al defined asset valuation in the context of engineering as “the art of estimating the fair monetary measure of the desirability of ownership of specific properties for specific purpose...engineering valuation is the art of estimating the value of specific properties where professional engineering knowledge and judgment are essential. ... based fundamentally upon [the asset’s] ability to produce some kind of useful service during its expected future life in service....” (Marston et al. 1963).

In transportation infrastructures context, asset valuation- or asset management in general, are implemented to fixed and unfixed tangible assets within or out of the right of way (ROW) (TAC 2013; TAC 2001). Examples of fixed assets within the ROW include: pavements, bridges, signs, signals, etc. Fixed and unfixed assets out of the ROW include: maintenance depots (Ex. salt sheds, fuel tanks, etc.), material stockpiles, laboratories, communication equipment, computer hardware, etc. In addition, Haas and Raymond identified other non-tangible assets such as intellectual property, land, etc. (Haas and Raymond 1999)

4.3 Asset Valuation Reporting Requirements

Agencies have accounting reporting requirements to report their TCA values in their financial statements and balance sheets. Of particular interest to this research are the Canadian Public Sector Accounting and Auditing Board (PSAAB) requirements and the Government Accounting Standard Board (GASB) in the United States.

The Canadian Institute of Chartered Accounts (CICA), has a comprehensive “Public Sector Accounting and Auditing Handbook” (CICA 1998) which indicates that “Financial statements are prepared by a government to report on its financial condition and result of operations ... information required to make assessments of and judgments on government financial operations and management.” Also, it indicates that “Financial statements should include ... a statement of tangible capital assets ... and the change in that investment in the period.” Section PS 1350 defines tangible assets as are non-financial assets having physical substance that: a) are held for use in the production or supply of goods and services, for rental to others, for administrative purposes or for the development, construction, maintenance or repair of other tangible capital assets; b) have useful economic lives extending beyond

an accounting period; c) are used on a continuing basis; and d) are not for resale in the ordinary course of operations. (PS 3150.05). The CICA has suggested that asset valuation should be based upon net book value for both financial and management accounting: “Governments that use the expenditure basis of accounting ... a statement of tangible capital assets that reports the net book value... Governments that use the expense basis of accounting should... report the net book value....”

In the United States, GASB issued Statement No. 34 was issued in 1999, “Basic Financial Statements for State and Local Governments” which requires state and local agencies to report the value of the assets they own (GASB 1999). The GASB requires that the value may be reported as the historical cost minus depreciation, or using a modified approach (Amekudzi et al. 2002; McNeil 2000).

GASB modified approach is that “Infrastructure assets are not required to be depreciated if: the government manages those assets using an asset management system that has certain characteristics and the government can document that the assets are being preserved approximately at (or above) a condition level established and disclosed by the government. Qualifying governments will make disclosures about infrastructure assets in required supplementary information (RSI), including the physical condition of the assets and the amounts spent to maintain and preserve them over time.” (McNeil 2000)

Other government requirements will also be studies in this research such as the Australian Accounting Standards Board (AASB), and New Zealand International Financial Reporting Standards (NZ IFRS).

4.4 Asset Valuation Methods

Asset valuation methods can be classified according to the time frame for asset valuation into past-based, current-based, and future-based methods (Amekudzi et al. 2002; Cowe Falls 2004). Past-based asset valuation methods use historical expenditures to determine the asset value, such as book value / historical costs (BV/HC). Current-based methods use current data to determine the value, such as replacement cost (RC), written down replacement cost (WDRP), etc. Future-Based methods use future data, such as Productivity Realized Market Value, Salvage Value, Figure 2.

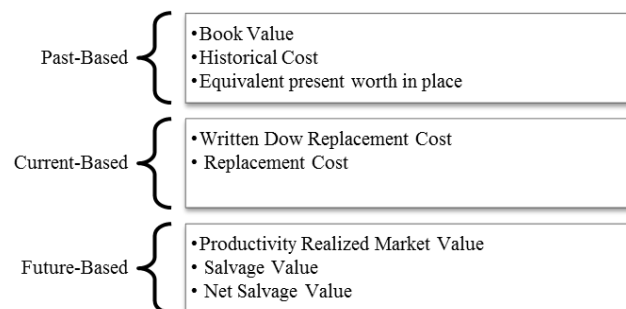


Figure 2: Asset Valuation Classification and Examples

There are various valuation methods that can be utilized to estimate infrastructure assets’ values such as book value, replacement cost, and written down replacement cost. Table 1 present example of asset valuation methods and basic definitions. It is recognized that there is no universally accepted method by the international community. However, it is noted that the book value and the replacement cost method are commonly used in highway infrastructure valuation (OECD 2001).

Table 1: Asset Valuation methods and Basic Definition (Adapted from (Amekudzi et al. 2002; TAC 2001))

Asset Valuation Method	Overview
Book Value	Present value based on historical costs depreciated to the present (commonly used for financial accounting purposes)
Replacement Cost	Present value based on cost of replacing/rebuilding the asset
Written Down Replacement Costs	Present value based on current replacement cost depreciated to asset current condition (commonly used for management accounting purposes)
Equivalent Present Worth in Place	The worth “as is”. The book Value adjusted for inflation, depreciation, depletion and wear; i.e., the (accounts for changes in prices and usage; applicable to comparing with other investments)
Productivity Realized Value	The value in use. Net present value of benefit stream for remaining service life (provides a reflection of relative importance of the asset)
Market Value	Price buyer is willing to pay
Net Salvage Value	Cost to replace the facility less the cost of returning it to ‘new condition’ Cost of materials
Salvage Value	Present worth of the amount obtainable from disposing or recycling Facility
Option Value	Value of asset in specific circumstances (Used by private sector)

As noted, there are various valuation methods that can be used to calculate infrastructure assets value. Each method requires a different set of data and results in different values. Examples of most common asset valuation methods in highway infrastructure asset valuation and the required data are presented Table 2.

Table 2: Data Requirements Asset Valuation Methods and (Li et al. 2014; Cowe Falls et al. 2004)

Valuation Method	Initial Construction (\$)	Current Construction (\$)	Maintenance/ Rehabilitation (\$)	Performance Condition	Age
Book Value	X		X		X
Replacement Cost		X			
Written Down Replacement Cost		X		X	
Net Salvage Value		X		X	X

4.5 Asset Valuation Integration in Asset Management

Several research activities have been undertaken in an effort to integrate asset valuation to the existing asset management practices. Cowe Falls et al introduced an asset valuation framework for highway assets, which follows the asset management framework of Figure 1 (Cowe Falls et al. 2001). The proposed framework suggests that in order to estimate the current asset value, three essential questions are to be addressed which need to be answered: What assets do we have and where are they? What is their condition or status? What valuation method should be used and what is their value?”(Cowe Falls et al. 2001)

Herabat et al introduced the application of cost based approach for pavement asset valuation integration with pavement management system (Herabat et al. 2002). The framework and the cost approach were applied on Thailand Pavement Management System (PMS). The generic cost approach is applied based on replacement costs and accrued depreciation over time. The cost approach captures the value of pavements based on their performance, which deteriorates over time, as well as the impacts of different maintenance activities applied to the pavements and other relevant variables such as the cost of materials, gasoline prices, and traffic volume. It was concluded that the cost approach focuses more on accounting principles than on economic principles; however, it is imperative that pavement valuation methods extend to include economic principles as well (Herabat et al. 2002).

Cowe Falls et al introduced the concept of Asset Service Index (ASI) as a potential integration mechanism in asset management systems (Cowe Falls et al. 2006). The index is calculated as the deviations from the expected value as a result of neglect, or changes in use that could accelerate or decelerate deterioration. ASI would be reported as a plus value indicating over-performing or a minus value indicating underperforming. The asset condition is represented in terms of remaining service life (RSL) by comparison either with the predicted point at which the condition reaches a minimum acceptable level or with age and adjusted by the replacement cost (RC), the ASI index is calculated as follows (Cowe Falls et al. 2006):

$$[1] \quad ASI = [(RC) * RSL / EL] \text{ Actual} - [(RC) * RSL / EL] \text{ Model}$$

Where; RC = replacement cost, RSL = remaining service life, and EL = expected life

Li et al studied the impact of using alternative performance measures in pavement condition assessment and valuation of pavement assets using Ministry of Transportation Ontario' Pavement Management System (Li et al. 2014). The performance measures studied include Pavement Condition Index (PCI), Riding Comfort Index (RCI) and Distress Manifestation Index (DMI). The study concluded that using alternative performance measures resulted in variation impact to the network evaluation and maintenance programing including the current and future conditions, identifying rehabilitation needs, and calculating asset values (Li et al. 2014).

5. ASSET VALUATION INDEX AND PROPOSED METHODOLOGY

Building on asset management state-of-the-practice, a methodology is developed to incorporate asset valuation as a performance measure in asset management framework. To achieve this objective, an Asset Valuation Index (AVI) is proposed. Data from Ontario Pavement Management System (PMS2) is utilized to develop and validate the proposed index as well as developing deterioration models for various maintenance and rehabilitation treatments. The deterioration models will be used to establish and evaluate the impact of treatments on asset values.

Preliminary assessment of various asset valuation methods is conducted to select the most appropriate method to establish the proposed AVI. One criterion for selecting the asset valuation method is its ability to capture the change in performance condition; due to deterioration or applying a treatment.

An illustrative example of some of the analysis is presented herein of three sample pavement sections from PMS2 database to demonstrate the concept of the proposed AVI. The three sections, namely A, B, and C, are homogenous sections with similar influence factors including: environment, traffic loading, subgrade material and thickness. All sections received a Mill and Hot Mix Overlay treatment at the same year. Figure 3 below shows the Pavement Condition Index (PCI) performance for the three sections over time.

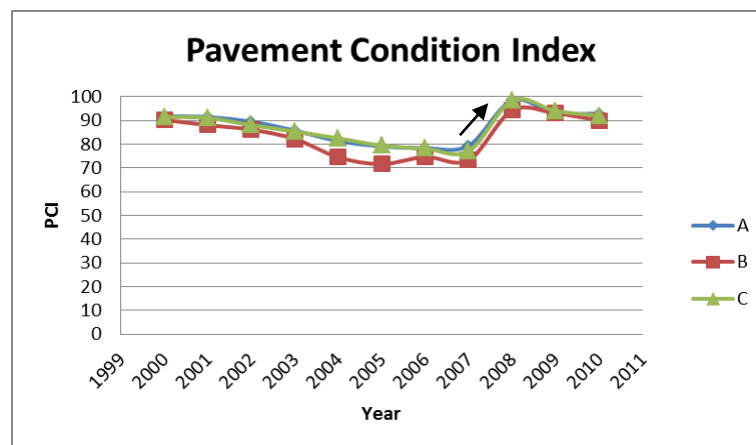


Figure 3: Sample Sections Pavement Condition Index

As indicated earlier, there are various valuation methods that can be utilized to estimate infrastructure assets' values. Of which, the written down replacement cost (WDRC) is commonly used (OECD 2001) and was selected for the

purpose of demonstrating the proposed methodology. Figure 4 shows the WDRC values of the three sample sections. As shown, the WDRC captures the change in condition due to treatment application and an increase in asset value is observed.

A change of asset value using the WDRC method can be represented by relative comparison over time as shown in Figure 4. In other words, over time the asset value will decrease as the asset deteriorates, and once a treatment is applied, the pavement condition improves and thus improving the asset value.

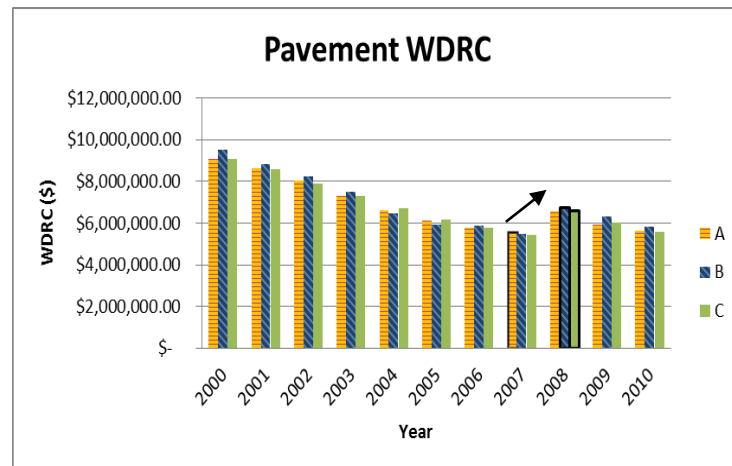


Figure 4: Sample Sections WDRC Values

Further analysis of performance models and asset valuation techniques is being carried out to develop the proposed index. The index is to be used as a performance indicator that can be incorporated in asset management tools.

To illustrate the proposed AVI, assuming a straight-line depreciation of asset value, the analysis will be conducted to evaluate the change in AVI as a result of applying or postponing a given treatment to preserve an asset as shown in Figure 5. The premise is that the return in investing in preserving the asset can be quantified through: the change and improvement in condition and the extended service life of the asset. The objective is to develop an AVI that can capture the return over the analysis period. This will improve the decision making, prioritization and optimization, as well as cross-asset optimization.

The proposed AVI index and the network condition will be evaluated against various LOSs to develop a methodology for establishing asset valuation performance measures and thresholds for performance specified types of contracts, PPP. Furthermore, using multi objective optimization tools, an optimization model will be developed that incorporates the proposed AVI and the performance level of service in its components to develop network multi-year maintenance program analysis.

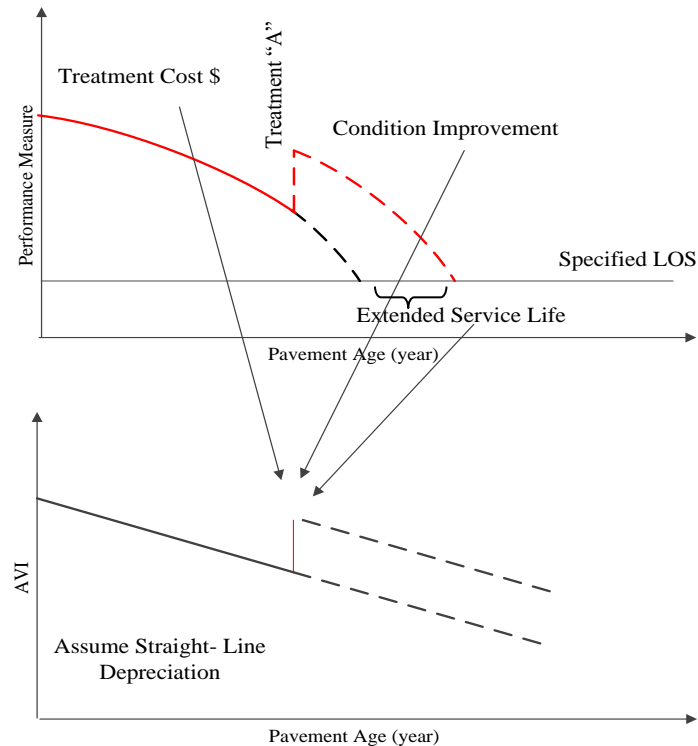


Figure 5: Concept Overview of Asset Value Index

6. SUMMARY AND CONCLUSIONS

Asset valuation is an essential component of effective asset management and an important method to demonstrate proper management of public assets and effective utilization of tax payers' money. Asset valuation allows agencies to demonstrate value of funds needed to preserve its assets. An integration method of asset valuation in asset management is imperative to manage assets in the most optimized cost-effective ways while maintaining or enhancing the value of these assets.

Further analysis of performance models and asset valuation techniques is being carried out to develop the proposed index. The AVI is to be used as a performance indicator that can be incorporated in asset management tools. The expected contribution of this research is to provide a better understanding of the application of asset valuation in the context of asset management. The research will implement asset valuation in a management/ engineering accounting as a key performance measure in asset management through the developed AVI. This is important to manage assets in the most optimized and cost-effective ways while maintaining or enhancing the value of these assets. Furthermore, the research will introduce a practical methodology that provides guidance in establishing effective asset valuation requirements in performance specified type of contracts, such as long term maintenance contracts and other PPP contracts.

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